was approached, until they were thoroughly understood; and recollect that we owe the discovery of them—by which we are enabled now to determine the pressures acting in the atmospheres of the most distant stars—simply to the fact that Dr. Wollaston, instead of drilling a round hole, used a slit; and to the other additional fact, that Mr. Simms, instead of using that slit with a mere prism, used a lens and made the beam parallel, and then allowed that parallel beam, after it had passed through the prism, to pass into another telescope, and form an image of the slit. You see how closely connected are the grandest discoveries with the skill and suggestiveness of those who supply different instruments for our use.

Now I must ask you to come back again to the prism. I have already told you that dispersion is the measure of the difference of the refrangibilities. If we take a prism which appears like an ordinary one, but really is composed of several layers of different kinds of glass, and pass an ordinary beam of light through it, it will be differently acted upon by the various layers, and we shall get a difference in the spectra. We have here, in fact, three distinct spectra, showing that there is something in the different layers of which this prism is composed which turns the light out of its path, and which disperses it more in some cases than it does in others. The cause of this is the density of the glass composing each layer: some kinds of glass are nearly twice as heavy as others, and fortunately we are not limited to glass, for if we were we should not be able to go so far in these inquiries as we do. The prism in reality consists of three separate pieces of glass of different density, and it may be seen that the three spectra obtained are differently refracted. It is a very natural conclusion that the heavier and denser glass should have a stronger action on the light than the lighter glass has. So that, in these inquiries, if we want to get great dispersion, not only must we use heavy glass, but we leave glass behind altogether, as amongst the liquids we find some which give even a greater dispersion than the densest glass. If a beam is passed through a hollow prism of glass filled with bisulphide of carbon, the spectrum obtained is much longer than that produced by the densest flint glass we can get. But there is another consideration to be borne in mind. The dispersive power and refractive power not only depend upon the density of the glass, but on the angles of the prism. If a beam of light is sent through two prisms of unequal angles the effect is extremely distinct. Thus, if we take one prism with an angle of 20°, and another with an angle of 60°, the larger angle gives us a much greater deviation and dispersion; therefore, we not only have density to help us, but we have also the angle of the prism.

And now let us go on to a third important point in the matter. We are not limited to one prism if we wish to get a great amount of dispersion; if you will think the matter over, you will see that there is no good reason why we should not employ two, and then you will find that the dispersion will be considerable. So you see, first, we have a single prism of a dense substance; by increasing the angle we get increased dispersion, and then we get it still further increased by adding another prism, and so we might go on, adding prism after prism, until we get to any number of prisms arranged in the best possible manner for the light to be successively dispersed by each of them. First of all, you have the dispersive power of glass, then you have the angle of the prism, and then you have a number of prisms, all of them capable of being so arranged that we can make them all useful in these inquiries, until at last we get a dispersion of such an enormous amount that the spectrum of the sun, as mapped by Kirchhoff and Bünsen, is several yards in length, although it is nothing but a succession of images of one of the finest slits which our best opticians are able to make.

You see, therefore, that our spectroscope depends first of all on Newton's work with the prism in 1675, and on the fact which Newton found out incidentally, that it is important that the prism should be used at the angle of minimum deviation. We then get the slit added by Wollaston in 1812; then the collimating lens, added by Simms, in 1830. In this way we have arrived at the spectroscope improved and modified as an instrument, until at last we get spectroscopes so arranged that the glass is of the finest possible material, the angle being the largest possible, the glass the densest possible, and the number of prisms as great as possible.

There are some other considerations connected with the manufacture of spectroscopes which it is hardly necessary I should bring before you, as they are rather more in the nature of detail than of general principles; but I must point out that where liquids are employed, it is absolutely essential that the temperature should be as equable as we can get it. A current of warm air in a room is quite sufficient to render any spectrum obtained by these liquid prisms perfectly useless; hence, although their great dispersive power is of great value in some cases, where we want dispersion more than anything else, still, as a rule, we are limited for nearly all our researches to these dense glass prisms of great angle, to which I have already alluded. But there is another consideration of great importance which comes in here. If the angle of a prism be large, a ray of light travelling from one prism to another, enters the second at an extremely small angle, under which circumstances a large amount of light is reflected, but still it is not better to use a greater number of prisms of a smaller angle than a smaller number of a larger one. Again in spectroscopes of many prisms it is essential that there should be some arrangement by which each part of the spectrum should be observed with each prism at the angle of minimum deviation for that ray. This may be done in many ways, and the beam may be made to pass back again through the prisms, thus doubling the amount of dispersion. On these points I shall have more to say presently.

Another important consideration, besides the purity of the material, is the perfect figure of the slit. You might imagine that the slit of a spectroscope was perfectly easy to make; but, judging by the results of the manufacture, it is extremely difficult, for a perfect slit is still very rare, the best being made by Steinheil of Munich. Mr. Browning has suggested making the slit of a compound of gold, which will not rust, or be acted upon much by temperature, and which also will take a good figure without any very great difficulty.

NORMAN LOCKYER.

(*To be continued.*)

NOTES

The Académie Royale de Belgique has elected Dr. Hooker "Membre associé." This has been done as their contribution to the Kew controversies. Prof. Monen, writing from Liege, is glad that Dr. Hooker has received "le plus haute distinction scientifique que notre pays peut conferer . . . dans une moment on vous (Dr. H.) soutenez une lutte vive et penible pour l'honneur de la botanique."

In their desire to uphold the standard of medical teaching, the authorities of Charing Cross Hospital have committed an act which presents the appearance of an injustice. Not only have they not elected anyone to the vacant post of Demonstrator of Anatomy at their school, but they have sent the following announcement to each of the candidates:—"Resolved: That in the opinion of this Committee, the gentlemen who have offered themselves as candidates for the Demonstratorship of Anatomy have not had sufficient practical experience in teaching anatomy to justify the Committee in selecting any one of them." The Committee would, of course, have been perfectly warranted in setting aside all the applications; but it was surely, to say the least, unwise thus to challenge criticism on the soundness of judgment of the Committee, since it is generally known that among the candidates was at least one who has had quite exceptional opportunities, not only for practical work, but also in teaching—Dr. Jas. Murie, who has been Demonstrator in Anatomy and Pathology to several medical schools both in Scotland and in London, has filled for some years the post of Prosector to the Regent's Park Zoological Gardens, and whose original papers and monographs (upwards of seventy in number) are universally recognised as evidence of quite unusual powers of research and demonstration. Our original workers are so few, and their opportunities of emolument so slender, that it is doubly hard that they should receive discouragement of this nature at the hands of a body specially bound to encourage the practice of original research.

AT a meeting of the Bombay Geographical Society on October 16, it was resolved to make arrangements to amalgamate that Society with the Bombay branch of the Royal Asiatic Society.

THE following are the names on the Cambridge Natural Science Tripos:—First Class—Whitmell (Trinity), Saunders (Down.), Teall and Yule (John's), the last distinguished in Comparative Anatomy and Physiology, and the last three equal. Second Class—Gaskell (Trin. H.), and Ranking (Cuth.), equal, Hebert, (Caius). Third Class—(all equal), Barron (Caius), Dew-Smith (Trin.), Knubley (Mag.), Marshall, W. C. (Trin.), Smith, J. (John's).

THE elements of the new planet (No. 128), discovered on the night of Dec. 4-5, by M. A. Barrelly, are given in the last number of *Astronomische Nachrichten*. It is of the tenth magnitude.

THE stations which the expeditions organised by the American government intend to occupy for the purpose of observing the transit of Venus will be mostly on the islands and coasts of the Pacific Ocean, from New Zealand on the south to the Aleutian Islands on the north, and from the Sandwich Islands on the east to China on the west. Telescopes and photographic apparatus for eight stations have been ordered from the firm of Alvan Clark & Sons, Cambridgeport, Massachusetts, and it is probable that nearly all the apparatus will be of American manufacture.

WE regret to announce the death of W. J. Macquorn Rankine, on Dec. 24, 1872, Professor of Engineering in Glasgow University. We hope next week to give an account of his life and labours.

WE regret to have to announce the death of Mr. Archibald Smith, LL.D., F.R.S., of Jordan Hall, Lanarkshire. Mr. Smith was born in 1814, studied at Glasgow and Cambridge Universities, being in 1836 Senior Wrangler and first Smith's Prizeman in the latter; the second wrangler was Bishop Colenso. He afterwards went to the Chancery bar, devoting his leisure to mathematical studies, his contributions to science being of high practical value. He was employed by Government to make a magnetic survey of the Antarctic regions, in connection with which he, in 1862, published his "Admiralty Manual for the Deviation of the Compass," which was republished and translated into various languages. Mr. Smith received from the Royal Society one of its Royal Medals, from the Emperor of Russia a compass set with diamonds, and recently from Her Majesty's Government a gift of 2,000*l.* as a mark of their appreciation of the value of his researches.

WE learn that the Brighton Aquarium Company propose eventually to embrace in their building sections representing Zoology and Ornithology. There are now in course of construction a large tank for *Reptilia*, and a seal pond. On Monday last a fine young seal was brought from the London Zoological Gardens, and is now the centre of attraction to visitors. There are also some very fine specimens of Axolotl (*Axoloteles guttatus*) lately received from Mexico. Considering the short time the aquarium has been in working order, and the loss of the late manager, Mr. Lord, the present efficient state of the building reflects great credit on all concerned.

AN examination will be held in Exeter College on Tuesday, January 28, 1873, and the following days, for the purpose of filling up four Scholarships and three Exhibitions. Two of the Scholarships are of the annual value of 80*l.* each, and two of them of 60*l.* each. To the latter, candidates born or educated for the three years last past in the diocese of Exeter have a prior claim, but only if they are duly qualified by their attainments to be scholars of the college. Otherwise these Scholarships also will be open. Of the Exhibitions one is worth 63*l.* per annum, the second is worth 50*l.* per annum, the third is worth 45*l.* per annum, and the holder of it, as also of the first, must apply himself to the study of Divinity. Candidates for the Scholarships must not have exceeded the twentieth year of their age on the day of election. There is no limit of age for the Exhibitions. One of the Scholarships and one of the Exhibitions will be given for proficiency in Natural Science, if sufficiently good candidates present themselves. Papers will be set in Chemistry, Physics, and Biology, but special weight will be given to excellence in Biology. Candidates in Natural Science must satisfy the College that they possess sufficient Classical knowledge to be able to pass responsions.

THE exhibition for National Science at St. John's College, Cambridge (51*l.* for three years), has been awarded to Mr. W. B. Lowe, who was educated at Rugby, and Mr. Taylor equal. McAllister, who highly distinguished himself in the examination for this exhibition and in mathematics, was elected to one of 40*l.* for four years.

MR. DITTMAR, of Edinburgh University, has been appointed Assistant-Professor and Junior Demonstrator of Chemistry at Owens College, Manchester.

MR. J. J. TAYLOR, of Giggleswick Grammar School, was elected on Wednesday, December 25, to a Natural Science-Exhibition, at St. John's College, Cambridge, for proficiency in chemistry and physics.

MR. ALEXANDER PEDLER, F.C.S., has been appointed Professor of Chemistry in the University of Calcutta.

WE are favoured by Prof. Griffis with a copy of the *Japan Daily Herald*, which contains some notes of the ascent of the volcanic mountain Fuji Yama, on September 8 and 9, 1872, by an officer stationed at Subashiri. From his own very careful observations, compared with that of others, and corrected by instruments at the Lighthouse Department at Benten, the officer estimates the total height at 13,080·32 ft. The only vegetation found on the summit was small lichens, while icicles hung from the rocks all round. There are a few stone huts on the summit, in which people live during the summer. The sides are lined with woods, principally firs, larch, birch, and mountain ash. The approximate diameter of the crater is given as 1,770 ft., and its depth 440 ft. The bottom of the crater appeared to consist of a small patch of sand, though it might have been dirty snow. The sides are all loose clinker, affording no foothold, unless with the assistance of a rope.

THE *Bulletin de la Société de Geographie* contains a paper by M. H. Duveyrier, on Livingstone's explorations, from 1866 to 1872, accompanied by a very pretty provisional map, which will no doubt require some alteration in the future. A paper on the Gulf Stream by M. E. Masqueroy, seeks to combat the theories advanced by Dr. Petermann in Nos. 6 and 7 of the *Mittheilungen* for 1870.

THE advanced sheet of the *Mittheilungen*, which Dr. Petermann has been good enough to send us, is occupied with an exceedingly interesting and carefully compiled abstract of the history of discovery in the most northerly region of Asia, between the Lena and Yenisei, from the year 1734 to 1866. This forms No. 73 of the papers on the geography and exploration of the Polar Regions, and is accompanied by one of those admirably constructed maps which form so enjoyable and valuable a feature of Dr. Petermann's invaluable periodical. The sheet also contains part of a second paper on Dr. Livingstone's exploration of the Upper Congo.

THE last number of *Le Tour du Monde* contains a "Revue Geographique" of 1872, devoted chiefly to African discovery.

AT a meeting of the managers of the Edinburgh Royal Infirmary, held on December 23, the following resolution was passed:—"That the managers of the Royal Infirmary resolve to admit females already enroled in the students' register for Scotland to receive clinical instruction, at a separate hour from that at which male students are admitted into the hospital, and in a stated number of wards, containing eighty beds, to which the female students must confine their visits; and remit to a sub-committee to make the requisite arrangements and alterations."

AT a meeting of the new Medical Microscopical Society held on December 6, Mr. Jabez Hogg was elected President, and a code of rules was adopted. The meetings will take place on the third Friday of each month, from October to July inclusive.

A MICROSCOPICAL *soirée* was given on the evening of Dec. 19, to the students of St. Thomas's Hospital, by the President and Secretary of the physical staff of that hospital (Mr. Wagstaffe and Dr. Evans).

WE learn from the *Athenæum* that the Earl of Derby would have formed one of the Arctic deputation, had he not been unavoidably detained in the country, and that he has expressed his cordial wishes for the success of the representation that has been made to Government.

THE *Revista del Sur*, of Chile, states that showers of sand occurred on July 3, in Araucaria, of sufficient extent to cover up all the planted fields of the Indians, and oblige them to take refuge on the north side of the mountain. This rain, supposed to have come from an eruption of Mount Llaima, distressed the Indians so much as to drive them into the neighbourhood of the white settlements.

THE Court of the Haberdashers' Company recently granted five exhibitions of 50*l*. each, for three years, to assist the holders (at Oxford, Cambridge, and London Universities) in their further educational or professional pursuits. Besides these exhibitions, 150*l*. was voted with a view to assist the education of children and grandchildren of liverymen. The same company has under its management five schools, new schemes for which are progressing with the Endowed Schools Commissioners.

THE November number of *Silliman's Journal* contains the first part of a very able paper by Prof. Joseph LeConte, in which he proposes his "Theory of the Formation of the great Features of the Earth's Surface." It is an admirable example of clear scientific reasoning and deserves the attention of all geologists, especially of those who believe the earth to be an extremely thin crust enveloping a molten and gaseous mass. He believes that Humboldt's formula, that all the effects of igneous agency are the result of "the reaction of the interior on the crust of the earth," must form the point of departure of every true theory; but in departing from this vague formula, only the most confused and contradictory notions seem to prevail among geologists. Mr. LeConte has for many years thought much on the subject, and his paper is an attempt to emerge from the chaos which now exists into something like clearness of perception on this supremely interesting point. He is convinced that the whole theory of igneous agencies—which is little less than *the whole foundation of theoretic geology—must be reconstructed on the basis of a solid earth.* Another very valuable article in this number is Mr. C. A. Young's "Catalogue of Bright Lines in the Spectrum of the Solar Atmosphere," which has already appeared in NATURE.

THE number of *La Revue Scientifique* for December 21, contains Prof. Hackel's introductory lecture on his taking possession of the chair of Zoology, recently founded in the University of Jena; the subject is "the Progress and Object of Zoology." The same number contains a notice of the institution recently founded at Haarlem, named "Bureau Scientifique central Néerlandaise," which proposes to do for Europe what the Smithsonian Institution does for America, effect with certainty, regularity, and a minimum expense, exchange of publications between the now very numerous European scientific societies. Any Society wishing to benefit by this mode of exchange, sends a sufficient quantity of its publications to the *Bureau*, which in return sends back to it copies of the publications of all the societies connected with it. At the end of the year the necessary expenses are divided among the various participating societies. The scheme looks plausible, and if well conducted might turn out to be very useful.

AS usual at this season of the year the Royal Institution is doing its best to purvey for eager holiday-making youth a judicious mixture of the *utile* and the *dulce*, and as usual it has been eminently successful, if we may judge from the delight with which the hundreds of boys and girls who filled the well-known theatre last week listened to Prof. Odling's fascinating story of Air and Gas. It will be seen from our diary that the second and third on the same subject will be given on Tuesday and Thursday next.

THE *Scientific American* contains some interesting statistics concerning the extremes of heat to which various parts of the world are subject. Probably the hottest country is Thibet, though its most southern part is 30° from the equator, its extreme summer temperature reaching to the height of 150°. The fact that the night temperature, even in summer, sometimes sinks to the freezing point, only serves to aggravate the discomfort of this extreme heat. Next comes Senegal and Guadaloupe, with a maximum temperature of 130°, that of Persia being 125°, while the maximum of Calcutta and the delta of the Ganges is 5° less. In Cape Colony and the African diamond diggings the midsummer heat is 105°, that of Greece being only one degree less, while that of the comparatively far north city of Montreal is only one degree less than Greece, and one more than New York. In Great Britain, Siam, and Peru, the extreme does not exceed 85°, while that of Siberia is as high as 77°, two degrees higher than in Scotland, and four above that of Italy. In Patagonia and the Falkland Islands the highest is 55°, ten degrees above that of Southern Iceland. In Nova Zembla the maximum temperature is only 34°, two degrees above the freezing point of water.

WE learn from the *Times of India* that while Mr. T. T. Cooper is about to make another attempt to penetrate into China from Momein, the well-known French traveller, M. Garnier, who was the leader of the French expedition through Yunan into China, is about to start on another expedition from China through Thibet to India. M. Garnier has already left Hongkong for Shanghai to commence preparations for his journey.

WE have received the prospectus of a new monthly half-crown magazine, to be commenced in January, and which we are told, has already received a large number of subscribers. It is entitled the *Practical Magazine*, and will be supported by original contributions from the pen of distinguished writers on commercial subjects and applied sciences. It will also be an illustrated cyclopædia of industrial news, inventions, and improvements, collected from Foreign and British sources, for the use of those concerned in raw materials, machinery, manufactures, building, and decoration. It will carry out what is greatly needed—a careful and systematic survey of the industrial activities of America, Germany, and France; in order to present such information, as it is useful for British practical men to obtain, at the earliest possible moment. Judging from the prospectus it seems calculated to serve a very excellent purpose, and we heartily wish it abundant success. We have also received the first number of a new sixpenny monthly entitled the *Workman's Magazine*, published by Messrs. Kent and Co., and edited by the Rev. Henry Solly, and chiefly devoted to articles connected with the social condition of the class whom it addresses. The editor, we think, might find a corner for science, the influences of which are now felt among all classes.

MR. WILLIAM STOKES, JUN., surgeon to the Richmond Hospital, has been elected to succeed Mr. Hargrave as Professor of Surgery to the Royal College of Surgeons, Dublin.

THE *British Medical Journal* understands that the University of Dublin, the King and Queen's College of Physicians, and the Royal College of Surgeons, have agreed upon a scheme for a joint examining board. The Queen's University, however, and the Apothecaries' Hall still stand aloof.

THE *Journal of Horticulture* says that a French farmer has discovered that the use of tan is an efficient preventive against potato disease. For three years he has introduced a small quantity of the residue of the bark used in tanning into each hole on planting his potato crop, and each time he has been completely successful in preserving his fields free from the annoying disease.

WE have received the catalogue of the mathematical and scientific works of the library of the late Mr. Babbage, which are in the hands of Messrs. Sotheby, Wilkinson, and Hodge. If not sold by private contract before February 1, 1873, they will then be sold by auction. The collection is one of rare value, and its dispersion would be an event much to be regretted. The catalogue fills 190 pages, and does great credit to the compiler.

THE *feuilleton* of the number for December 28, of the *Gazette Médicale de Paris*, contains the concluding part of M. Dumas' admirable *éloge* on the late Isidore Geoffroy Saint-Hilaire.

WE learn from the *Engineer* that Mr. Eden, indoor engineer in the Edinburgh Telegraph office, has invented a system by which, with the existing instruments, it has been found practicable to send messages from both ends of a single wire simultaneously The invention has been tested between Edinburgh and Glasgow, and it has been found that one wire is capable of doing double work.

WE learn from *Ocean Highways* that considerable anxiety prevails in Sweden respecting the safety of the vessels attached to the expedition which were to have returned at the close of the navigable season. The brig *Gladan*, and steamer *Onkel Adam*, took out stores for the *Polhem*, and were to have returned before the winter set in. They are totally unprepared for wintering in the ice; and should they not be able to return, it will be necessary for the crews to abandon the vessels and take refuge in the *Polhem*, which in that case will be overcrowded, and crippled in her resources. The Norwegian Government has despatched to their relief the seal steamer *Albert*, which will make an energetic attempt to reach Spitzbergen. She takes out two wooden houses, to erect inshore at the most likely places for stragglers to find them, and abundant supplies.

*TERRESTRIAL MAGNETISM**

I.

IN bringing before you this evening, gentlemen, the subject of terrestrial magnetism, it is not my intention to attempt to present you with an exhaustive paper on so wide a subject. It would be idle to pretend to give in a few short pages an adequate idea of all that has been ascertained on this subject, or even to present a satisfactory historical sketch of the progress made from earliest ages to the present time. Nor will I trouble you with a bare enumeration of the many facts, and methods, and theories that have gradually led scientific men to their present knowledge in this matter. But I will try rather to state, as clearly as I am able, what is the actual condition of our knowledge respecting the magnetism of the globe, and what the nature of its complex variations, without, however, entering much into details which, though they might perhaps be most convincing when reviewed at leisure, would be entirely out of place here, since they would only serve to encumber a paper intended for public perusal.

But, before treating of the special subject of terrestrial magnetism, allow me briefly to recall a few of the well-known properties of magnets.

That certain bodies possess the power of attracting iron was not unknown to the most ancient people; and men who had noticed this could not long have failed to observe the disturbing power that iron, in its turn, exerts upon the magnet when brought into its immediate neighbourhood.

But the duality of the magnetic force was doubtless a discovery of much more recent times, though now equally familiar as the former. That this twofold force ever seeks the opposite extremes, or poles, of a magnetic body, and that these poles, whilst possessing alike the power of attracting iron, are diametrically opposed in their action upon the poles of any other magnet, is expressed in the trite law that, "likes repel, and unlikes attract." Again, the law of magnetic intensity was unknown until the middle of last century, when it was found by Michell to be identical with that of universal gravitation, namely, to diminish inversely as the square of the distance of the body attracted. That this was not discovered at an earlier date is partly due to the complexity of the phenomena arising from the duality of the force, combined with the inseparable nature of the two energies. For, unlike electricity, to which in most other points it is so near akin, neither the positive nor the negative element of magnetism can ever exist alone in any body.

Now, since we know that magnets and iron act mutually upon each other, and that one magnet attracts or repels any other according to certain fixed laws, if we remove all disturbing bodies from the vicinity of a magnet, and leave it perfectly free to move by floating it on a liquid, or suspending it by a thread, we might expect to see the magnet remain at rest in whatever position we place it. But we perceive at once that this is not the case, and the magnet we thought to be free is found to be subject to a directive power, which forces it to take a fixed direction, without in the least interfering with the position of its centre of gravity. Disturb the magnet, and when it comes to rest it will again lie in the same direction as before. The earth, therefore, exerts a certain influence on the magnet, not producing any translation from one position to another, but only forcing the poles of the magnet to assume a definite direction. That this power possessed by the earth is precisely similar to that of an ordinary magnet, is easily shown by counteracting the earth's action by means of a magnet, placed at a suitable distance from the free magnetic needle, and with its marked end in the same direction as that of the needle, the latter will then rest in any position in which it is placed.

This polarity, or directive power of the earth, is said to have been known to the Chinese 1,000 years at least before the Christian era, and to have aided them in their long journeys across the trackless wastes of their vast empire. The use that has since been made of this simple fact, the growth of commerce, the spread of civilisation, and the thousand other blessings that it has brought to our very doors, need no long comment here. We may well marvel that such a source of wealth and prosperity was allowed by mankind to remain almost fruitless during such a long succession of ages.

The horizontal direction taken by the freely suspended needle

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* By the Rev. S. J. Perry, F.R.A.S., F.M.S., Director of the Stonyhurst Observatory. Extracted from the *Journal of the Liverpool Polytechnic Society*, by the permission of the Council. Communicated by the author.